Pandemic Preparedness of Countries to Cope With COVID-19

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Research Article

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PANDEMIC PREPAREDNESS OF COUNTRIES TO COPE WITH COVID-19

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Abstract

One of the problems hardly clarified in COVID-19 pandemic crisis is the effective of the pandemic preparedness of countries to cope with COVID-19 and reduce negative effects in society. The study here confronts this problem by proponing the Index of resilience that detects which countries have had the best performance to reduce the negative impact of mortality related to COVID-19 pandemic and the Index of preparedness that assesses performance of countries to support COVID-19 vaccinations and prevent future waves of COVID-19. The application of these indexes on selected European countries suggests that, in average, best-performer countries to cope with COVID-19 pandemic crisis have a smaller size of population and high level of health expenditures. However, lessons learned from this study are that manifold countries have several biological security weaknesses and low pandemic preparedness. The policy implications are that governments should revise and reinforce, planning, institutions and overall organization devoted to face pandemic threats.

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Introduction

Coronavirus disease 2019 (COVID-19) is an infectious disease caused by the novel Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2), which appeared in late 2019 (Coccia, 2020). COVID-19 is still circulating in 2021 with variants of the novel influenza coronavirus and continue to be a constant pandemic threat in manifold countries generating higher numbers of COVID-19 related infected individuals and deaths (Johns Hopkins Center for System Science and Engineering, 2021). One of the problems hardly clarified in COVID-19 pandemic crisis is the measurement of preparedness of countries to cope with COVID-19 pandemic crisis and to prevent the diffusion of new pandemic waves driven by variants of the novel coronavirus. In this context, scholars and institutions endeavor to measure, assess and analyze the impact of the COVID-19 considering geographical characteristics, political systems, climate factors, level of economic growth, etc. of cities, regions and countries (Coccia, 2020a, 2020b, 2021, 2021a, 2021f, 2021g; Lowy Institute, 2021). Although these studies, the critical factors affecting the performance of countries to cope with COVID-19 pandemic crisis and similar infectious diseases in society are hardly known. This study proposes two indexes, based on vital factors, that measure and assess in a comparative analysis the best performance of countries directed to lower mortality of COVID-19 and to cope with future epidemics in society.

In particular, this study has two goals. First, to propose an index that quantifies and assesses which countries have had the best performance to reduce the negative impact of unforeseen COVID-19 pandemic; second, to suggest an index that measures the performance of countries to prevent the diffusion of future epidemics of the COVID-19 and related variants in society. This study focuses on data of European countries because of a similar economic structure and background given by European area. The performance of countries in a comparative analysis can show variations between countries in the handling of the COVID-19 pandemic crisis in order to determine, whenever possible, vulnerabilities and points of strengths based on critical factors underlying socioeconomic structure and policy responses for combatting the coronavirus and constraining negative effects given by higher mortality of current COVID-19 pandemic crisis and future pandemics of similar infectious diseases.

The crux of the study here is rooted in the concept of performance and comparative evaluation system of countries, applied here to cope with diffusion of pandemics in society, and some brief backgrounds are useful to understand and clarify it. Firstly, an evaluation system is a systematic process for data collection, measurement, and analysis of the characteristics of different entities to generate a final rating and support decision making processes of stakeholders for specific goals. Secondly, an evaluation system is based on a stable set of techniques and tools to compare different units (organizations, countries, etc.) over time and space. In this context, a comparative performance system is a set of elements and processes to assess the capability of individuals, organizations, and other subjects to achieve strategic goals using, as benchmark, the performance of similar subjects and/or the previous performance of the unit itself. A comparative performance system supports decision-making of management and policymakers directed to accomplish strategic targets and satisfy stakeholders in turbulent contexts. These concepts provide a theoretical background for creating new indexes to measure preparedness of countries to cope with COVID-19 pandemic crisis and ranking their performance.

The novel Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2) that caused the Coronavirus Disease 2019 (COVID-19), as said, continues to be a constant pandemic threat in 2021 with new variants of the SARS-CoV-2, such that manifold countries have a state of emergency because of high numbers of COVID-19 related infected individuals and deaths in society (Coccia, 2020, 2021a). The COVID-19 pandemic crisis needs rapid a policy response based on efficient health systems, development of innovative drugs, new vaccines with consequential development, manufacturing, distribution, allocation, and administration (National Academy of Medicine, 2021, 2021a). In particular, the management of vaccination to cope with COVID 19 pandemic plays a vital role to constrain current and future negative effects in society (DeRoo et al., 2020; Frederiksen et al., 2020; Harrison and Wu, 2020). In fact, the management of COVID-19 vaccination is a significant challenge for all countries globally because it is associated with manifold economic, socio-cultural and institutional factors. Economic factors are a relevant component since coronavirus vaccination involves effective public investment and efficient organization from procurement, appointments, giving 1st and 2nd dose vaccinations (Ethgen et al., 2018; cf., GOV.UK, 2021; NHS, 2021). Anttiroiko (2021) analyzes how socioeconomic context, institutional arrangements, culture, and technology level can affect national responses to the pandemic in Eastern and Western countries. The study reveals that Asian countries reflect proactivity, whereas Western countries provide reactive policy responses (cf., Coccia, 2021b). In general, crisis management of COVID-19 pandemic is based on effective multi-level governance, combining both national, regional and urban strategies to provide timely policy responses and improve safety in society (Anttiroiko, 2021). Studies show that on average policy responses in Europe tend to be less stringent interventions than countries in East Asia (Ritchie et al., 2020). Abuza (2020) argues that the effectiveness of policies is based on leadership and competence, rather than political regimes of countries. Moreover, Anttiroiko (2021) highlights that Asian countries have applied with determination their policy responses to COVID-19 crisis because of the early diffusion of pandemic that has induced learning processes supporting improved capabilities of crisis management. In fact, successful policy responses among Asian countries are due to early travel restrictions, quarantine arrangements, effective social distancing, associated with efficient healthcare systems, collective learning and knowledge-intensive approaches. Instead, European countries have different culture, political systems and different approaches for copying with crises (Anttiroiko, 2021). In context of crisis management, European countries have to face privacy and human rights issues, associated with demonstrations against governments for socioeconomic problems of businesses closures, etc. that slow down the implementation of restriction policies and/or reduce the effects with a subsequent increase of the transmission dynamics of COVID-19 (Coccia, 2021c, 2021d, 2021e). In fact, factors associated with governance of countries was found to play a vital role for the management of new vaccines in poor African nations (Glatman et al. 2010; Glatman-Freedman and Nichols, 2012). Worldwide Governance Indicators (2021) states that "Governance consists of the traditions and institutions by which authority in a country is exercised. This includes ...the capacity of the government to effectively formulate and implement sound policies; and the respect of citizens and the state for the institutions that govern economic and social interactions among them". In modern societies, this specific function is shared between government, public administration and economic forces.

Hence, the pandemic of COVID-19 and future epidemics/pandemics of similar viral agents challenge global societies that are susceptible to infectious diseases. In global environment of the world, it is more and more important to design new indicators that can help policymakers to measure performance of countries, and assess organizational and institutional weaknesses to the exposure of new infectious disease in order to improve future policy responses that contain and/or prevent negative effects of pandemics on public health and economy.

Materials and methods

1.1 Research setting, measures and sources

The study here is a specific analysis of European countries having a homogenous socioeconomic background given by European area.

Period under study is from February 2020 to March 2021

The principal factors associated with COVID-19 pandemic are assumed to be:

- *Factor* 1: Mortality rate is given by (number of deaths divided by population of country) × 100 000 inhabitants at 1st March 2021. Lau et al. (2020) argue that actual case numbers appear vague, whereas mortality number related to COVID-19 can be a precise indicator of the negative impact in society. Hence, the mortality rate is a main indicator to evaluate the effects of COVID-19 in society, reducing whenever possible underreporting and/or under detection of COVID-19 cases. Source of data: Johns Hopkins Center for System Science and Engineering, 2021.
- *Factor* 2: Average daily hospital occupancy × 100 000 inhabitants, using average weakly data of country from 24 February 2020 to 14 February 2021. Daily hospital occupancy indicates number of COVID-19 patients in hospital on a given day. This indicator provides main information about the effects of pandemic on health systems and as a consequence in society (Faes et al., 2020). Source: European Centre for Disease Prevention and Control (2021)
- *Factor* 3: Average Intensive Care Units (ICUIs) occupancy × 100 000 inhabitants, using average weakly ICU data of country from 24 February 2020 to 14 February 2021. Daily ICU occupancy is the number of COVID-19 patients in ICU on a given day. This indicator also provides main information about the effects of pandemic in society. Source: European Centre for Disease Prevention and Control (2021)
- *Factor* 4: Doses of vaccines administrated × 100 000 inhabitants at February-March 2021. Doses of vaccinations refer to the total number of vaccine doses, considering that an additional dose may be obtained

from each vial (e.g. six doses for Pfizer BioNTech® Comirnaty), whereas number of doses administered refers to any individual receiving any dose of the vaccine (cf., Freed et al., 2021; Oliver et al., 2020). Source: Our World in Data (2021).

- *Factor* 5: Total Vaccinates × 100 000 inhabitants at February-March 2021(cf., Dooling et al., 2020; Cylus et al., 2021; GOV.UK, 2021; NHS, 2021; Covid-19 Opendata Vaccini, 2021; Presidenza del Consiglio dei Ministri, 2021). Sources: Lab 24 (2021), Our World in Data (2021).
- Additional factors. Population in Europe in the 2020. The number of persons having their usual residence in a country on 1 January of the year 2020. When usually resident population is not available, countries may report legal or registered residents. Source: Eurostat (2021).
- Control factors. Average current health expenditure (% of GDP) over 2016-2018 (last data available) is a proxy of the efficiency of health systems. Level of current health expenditure expressed as a percentage of GDP includes healthcare goods and services consumed during each year. This indicator does not include capital health expenditures, such as buildings, machinery, IT and stocks of vaccines for emergency or outbreaks. Source: World Bank (2021).
- Control factors. Lockdown as containment measure is given by the sum of days per countries of restriction policy for people from starting of COVID-19 pandemic in 2020; in particular, lockdown is a temporary condition imposed by governmental authorities during the outbreak of an epidemic disease to people or communities requiring to stay in their homes and refrain from or limit activities outside the home involving public contacts (such as dining out, shopping in mall, attending large gatherings, etc.; cf., Coccia, 2021c).

1.2 *Index r (as resilience) of countries*

- Index r indicates the capacity of health system preparedness and in general of the governance of countries to minimize the mortality rate in the presence of rapidly changing scenarios given by pandemic threat in society.

Step 1.

Let Factor i (i=1, 2, 3), just mentioned, observed per j units (e.g., regions, countries, etc.) with j=1, …, n countries

In particular,

F1*j*= Mortality rate × 100 000 inhabitants in country *j*

F2*j*= Average daily hospital occupancy × 100 000 inhabitants in country *j*

F3*j*= Average Intensive Care Units (ICUIs) occupancy × 100 000 inhabitants in country *j*

j=1, …, *n* countries

Step 2.

Let

$$I_{1j} = \frac{F1j}{100\,000} \ with \ \ 0 < I_{1j} < 1$$

$$I_{2j} = \frac{F2j}{100\,000} \ with \ \ 0 < I_{2j} < 1$$

$$I_{3j} = \frac{F3j}{100\,000} \ with \ \ 0 < I_{3j} < 1$$

For country j, in the period *t*,

$$Index\ r(resilience)j = \sum_{i=1}^{3} \frac{Iij}{3} \ with\ 0 < Index\ r, j < 1; \ \ j = 1, \dots, n\ countries \qquad [1]$$

The ranking of the Index *r* for *j* countries in increasing order indicates the performance of resilience of countries in terms of health system preparedness in the presence of an unforeseen pandemic threat; in particular:

- Index *r, j* = 0 indicates the best performer country *j* with a low negative effect of pandemic threat in terms of mortality rate in society
- Index *r* , j = 1 indicates the worst performer country *j* with a high negative effect of pandemic threat in terms of mortality in society

1.3 Index p (as preparedness) of countries

Index *p* indicates the capacity of the governance of countries to stop and/or reduce the impact of future pandemic threat by maximizing the vaccinations and supporting rapidly a normal operation of economic systems satisfying population needs.

Step 1.

Let Factor *i* (*i*=4, 5), just mentioned, observed per *j* units (e.g., regions, countries, etc.) with *j*=1, …, *n* countries. In particular, here,

F4*j*= Doses of vaccines administrated × 100 000 inhabitants in country *j*

F5*j*= Total Vaccinates × 100 000 inhabitants in country *j*

Step 2.

I*ij* is composed by:

$$I_{4j} = \frac{F4j}{100\,000} \ with \ \ 0 < I_{4j} < 1$$

$$I_{5j} = \frac{F5j}{100\,000} \ with \ \ 0 < I_{5j} < 1$$

For country *j*, in the period *t*,

$$Index\ p\ (prevention)j = \sum_{i=4}^{5} \frac{Iij}{2}\ with\ 0 < Index\ p, j < 1\ ;\ j = 1, \dots, n\ countries \qquad [2]$$

As the goal is the maximization of vaccination, the ranking of the Index *p* for *j* countries in decreasing order indicates the performance of the governance of countries to stop and/or reduce the impact of future pandemic threat supporting an optimization of vaccinations for leading rapidly to a normal operation of economic systems and satisfaction of population needs.

In this case,

- Index *p, j* = 1 indicates the best performer country *j* with a high proactive capacity to stop epidemics and support a recovery of economic system, satisfying population needs
- Index *p* , j = 0 indicates the worst performer with a low capacity of reaction and adaptation to stop future negative effects of pandemic threats and consequential damages for socioeconomic systems

Properties of the indexes:

- *Range of variation.* Indexes have a range of variability in the set of real numbers given by [0, 1]
- *Transitive property.* If $F_{i,j} \leq F_{i,j+1} \Rightarrow indexes_{j} \leq indexes_{j+1}$
- *Symmetry property.* If $F_{i,j} = F_{i,j+1} \Rightarrow indexes_{j} = indexes_{j+1}$

for i=1, …, m factors, j=1, …, n countries

The j-th units (countries) are classified from 1st to *n-th rank* according to the value of suggested indexes. In particular, a rank close to the 1st position indicates a best performer country for proposed index, a rank close to n (*last position*) suggests a worst performer country in terms of resilience and preparedness of pandemic threat.

This novel method of measuring performance of countries to cope with pandemic threat with indexes that synthesize multivariate factors, representing them to rank countries is an important findings because this ranking presentation makes it easy for the human mind to grasp many of the essential aspects of general performance of countries in the presence of pandemic crisis.

Results and discussion

The application of proposed indexes is based on a specific analysis of European countries having a homogenous socioeconomic background given by European area. Because of missing values of some factors to make a comparative analysis of performance, using proposed indexes, when there is a missing value the country was discarded, as consequence the number of countries in the ranking can differ in the suggested index of resilience and preparedness of pandemic threat.

Table 1. Index *r* of resilience (*Ir*) of some European countries to cope with COVID-19 pandemic crisis

Countries	*Ir*(%)	Performance
Finland	0.008	Best performer
Iceland	0.011	
Denmark	0.022	
Cyprus	0.023	
Estonia	0.039	
Netherlands	0.049	
Ireland	0.051	
Austria	0.060	
Average of high performers (HP)	**0.033**	**Group of HP for *Ir***
Luxembourg	0.072	
Sweden	0.073	
Spain	0.082	
Portugal	0.096	
France	0.107	
Bulgaria	0.112	
Slovenia	0.113	
Belgium	0.114	
Italy	0.117	
Czech Republic	0.122	Worst performer
Average of low performers (LP)	**0.101**	**Group of LP for *Ir***

Note: the categorization of countries in high or low performers is based on countries having scores higher or lower than arithmetic mean of the final sample countries having all factors 1, 2 and 3 to calculate Index of resilience(I*r*)

Table 2. Characteristics of countries having high or low performance of the Index *r* of resilience (*Ir*) to cope with COVID-19 pandemic crisis

	Descriptive statistics	Performance *Ir* of resilience	Population 2020	Current health expenditure (% of GDP) over 2016-2018	Lockdown Days 2020-2021
High Performers	Mean	0.0003	5,615,861.00	8.57	51.50
	Std. Error of Mean	0.0001	1,962,629.71	0.56	14.40
Low Performers	Mean	0.0010	22,623,833.10	8.79	66.30
	Std. Error of Mean	0.0001	7,947,185.94	0.58	15.75

Table 3. Index *p* of preparedness (*Ip*) of some European countries to stop COVID-19 pandemic crisis

Countries	*Ip*(%)	Performance
United Kingdom	18.35	Best performer
Malta	13.00	
Hungary	8.17	
Denmark	7.97	
Iceland	7.35	
Norway	7.31	
Estonia	7.15	
Poland	7.08	
Switzerland	6.92	
Lithuania	6.83	
Greece	6.80	
Average of high performers (HP)	**8.81**	**Group of HP for *Ip***
Ireland	6.54	
Slovenia	6.49	
Slovakia	6.44	
Portugal	6.43	
Romania	6.25	
Spain	6.19	
Italy	6.09	
Finland	5.89	
Germany	5.86	
France	5.67	
Belgium	5.64	
Sweden	5.25	
Czech Republic	5.13	
Netherlands	4.83	
Luxembourg	4.69	
Croatia	3.70	
Bulgaria	2.42	
Latvia	2.18	Worst performer
Average of low performers (LP)	**5.32**	**Group of LP for *Ip***

Note: the categorization of countries in high or low performers is based on countries having scores higher or lower than arithmetic mean of the final sample countries having all factors 4 and 5 to calculate Index of preparedness (I*p*)

Table 4. Characteristics of countries having high or low performance of the Index *p* of preparedness (*Ip*) to stop COVID-19 pandemic crisis

	Descriptive statistics	Performance *Ip* of preparedness	Population 2020	Current health expenditure (% of GDP) over 2016-2018	Mortality rate × 100 000	Lockdown Days 2020-2021
High Performers	Mean	0.09	13,615,059.36	8.54	83.21	67.73
	Std. Error of Mean	0.01	6,179,342.81	0.55	17.42	22.98
Low Performers	Mean	0.05	20,434,608.83	8.37	126.31	55.44
	Std. Error of Mean	0.00	5,984,334.39	0.46	10.74	10.14

In the presence of COVID-19 pandemic crisis, it is more and more important to explain underlying factors that can support better policy responses as well as organizational and institutional weaknesses to the exposure of infectious disease in order to provide lessons learned directed to improve future policy responses that contain and/or prevent negative effects of pandemics on public health and economy. In this context, to synthetize multivariate factors of performance of countries in a simple index to grasp intuitively the general capacity of resilience and preparedness of countries plays a vital role to cope with current and future pandemic threats. In this paper, indexes are proposed as new method that quantifies the ability of countries to cope with pandemic threat and/or prevent new pandemics assessing resilient health systems, good governance and effective policy response.

Table 1 and table 2 show that higher capacity of preparedness to cope with COVID-19 pandemic crisis, reducing mortality rates, is by countries having a smaller population of about 5.6 million with average health expenditure (% of GDP) of 8.6%, regardless a shorter period of lockdown of roughly 51 days. Instead, countries with lower resilience to cope with COVID-19 pandemic crisis, with higher mortality rate, have larger size with more than 22.5 million of population, though a longer period of lockdown (cf., Coccia, 2021b).

As far as the characteristics of countries having high performance of the Index *p* of preparedness (*Ip*) to stop COVID-19 pandemic crisis with a proactive public policy of vaccinations are based on a size of population of about 13.6 million, which is lower than countries (about 20.4 million people) with a scarce capacity of preventing future pandemic waves having reduced vaccinations in population. High-performer countries for index *p* have also higher average health expenditure (% of GDP) over 2016-2018 (i.e., 8.5%) and a longer period of lockdown of about 68 days. High-performer countries for index *p* they have an average mortality rate per 100 000 people lower than countries with reduce magnitude of this performance index (83.21 vs. 126.31 respectively).

The results seem to suggest that better performance to cope with COVID-19 pandemic crisis are in countries having a smaller size. The vital role of population size in the diffusion of diseases and strategy of crisis management for COVID-19 is a basic factor (cf., Coccia, 2021b). Shi et al. (2021) argue that many diseases exhibit population-specific causal effect sizes with trans-ethnic genetic correlations. Milner and Weyman-Jones (2003) maintain that there is also some evidence of a country size constraint on efficiency when other influences are controlled for. Molino (2005) shows that when population grows beyond the minimum level of welfare, the overall economy becomes more dynamically inefficient. Frankel (2012) argues that various great powers can be models of economic and social development but small countries can set new institutions and new policies with positive socioeconomic effects in shorter period, though no one size fits all (cf., Coccia, 2018, 2019, 2019a).

These results here endeavor to explain factors associated with relations on how a country develops resilience in the presence of pandemic threat and efficiency of crisis management in the short and medium term. The concept of a resilient recovery underpins many national and international recovery plans (Sagan et al., 2020). Williams et al. (2020) argue that effective responses to public health emergencies should rely on translating rapidly emerging research into timely, evidence-informed policy and practice. Resilient systems to pandemic shocks must have strong governance structures driven by adequate and effective leadership that engages with communities and adapts to population needs. Efficient governance can support health system preparedness in the presence of turbulent scenarios given by pandemic crisis and new population needs. Moreover, countries with constant investment in health sector and preparedness can reduce mortality, morbidity and stress among the population as well as promote public health and economic recovery after pandemic crisis (Kluge et al., 2020; Coccia, 2021b). Sagan et al. (2020) confirm that among European health system functions, effective governance is a critical factor to a resilient response in the presence of crisis. Critical aspects of resilient responses of countries to COVID-19 pandemic crisis can be: 1) appropriate and effective governance and 2) technical capacity to respond in a short period of time. In particular, governance is more and more a necessary condition for effective policy responses to cope with COVID-19 pandemic crisis. In fact, Sagan et al. (2020) consider a broad concept of governance not limited to health system alone, but governance is a complex system that creates the background to support other functions of nation and its government to work properly and strengthen health, economic and social systems. Hence, to cope with novel influenza viruses that continue to be a constant pandemic threat worldwide, the health sector is just one element of a comprehensive strategy of preparedness. As a consequence, strategies directed to enhance resilience have to be based on different approaches for supporting both policy responses of short run to cope with current pandemic threat and long run interventions to prevent future social and health issues. In this context, improvisation is also a way of taking advantage of important and unexpected opportunities without formal plans or systematic procedure (Sharkansky and Zalmanovitch 2000). While rational planning aims to control a situation by reducing the uncertainty in the long run, improvisation is a reaction of short term to a novel situation and a way of working within uncertainty. Improvisation can be useful because is a combined behavioral and cognitive activity that requires consequential creativity under tight time constraint in order to meet performance goals in the presence of environment threats or hazardous situations (Mendonça and Fiedrich 2006).

Concluding remarks

COVID-19 and future epidemics of novel influenza viruses pose, more and more, a serious threat to national security and public health. An influenza pandemic can occur at any time with little warning; any delay in detecting a novel influenza strain; sharing of influenza virus samples; and in developing, producing, distributing, or administering a therapeutic or vaccine could result in significant additional morbidity and mortality, and deterioration of socioeconomic systems in the long run. The global response to COVID-19 pandemic has pushed the boundaries on what is possible for rapid pandemic response in several areas, including healthcare system, vaccine research, new technologies, environment as well as development, manufacturing, distribution, allocation, and administration of innovative drugs and vaccines[1]. These actions have to trigger learning processes to support preparedness efforts to advance timely public responses in the short term and R&D for innovative drugs and new

[1] Cf. also studies by Coccia 2005, 2005a, 2014, 2017, 20171, 2017b, 2017c, 2018, 2018a, 2018b, 2018c, 2018d, 2018e, 2019, 2019a, 2019b, 2019c, 2019d, 2019e, 2019f, 2019g, 2020c, 2020d, 2020e, 2020f, 2020g, 2020h, 2020i, 2021h, 2021i, 2021l;Coccia and Bellitto, 2018; Coccia and Finardi, 2012, 2013; Coccia and Rolfo, 2008; Coccia and Watts, 2020; Pagliaro and Coccia, 2021.

pandemic vaccines. New strategies of nations in the presence of environmental threats have to be highly responsive, flexible, resilient, scalable, and more effective for reducing the impact of seasonal and pandemic influenza viruses (Ardito et al., 2021).

This approach of crisis management is directed to three strategic goals in the presence of a constant pandemic threat:

- Strengthen and diversify vaccine development, manufacturing, and supply chain
- Promote innovative approaches and use of new technologies to detect, prevent, and respond to transmission dynamics of epidemics and pandemics; and
- Increase vaccine access and coverage across all populations in the presence of unforeseen pandemic of novel viral agents.

In addition, to adequately prepare for, prevent, detect, and respond to both epidemics and inevitable pandemics, it is basic to invest in domestically-based seasonal and pandemic preparedness efforts by collaborating with domestic and international stakeholders across different sectors. Execution of this strategic approach over the next ten years will require innovative partnerships, financial investments, and efficient utilization of resources (U.S. Department of Health & Human Services, 2021).

In short, policies having agility and speed of responses can generate a competitive advantage to cope with social threat of new waves of COVID-19 and future epidemics/pandemics similar to COVID-19 (Chang et al., 2020; Janssen and van der Voort, 2020; Renardy et al., 2020). Evans and Bahrami (2020) pinpoint that super-flexibility can be an appropriate approach to cope with COVID-19 pandemic in which decision making is oriented to versatility, agility, and resilience. The complex and unforeseen problems should be treated with approach of dissolution, rather than solution and/or resolution: Dissolution means to redesign either the organization that has the problems or the environment in order to eliminate the problems or sources of problems, thus enabling the organization to do better in the future than the best it can do today. Moreover, stakeholders might seize upon the lessons of crises to advocate measures, policies and organizational reforms to improve the overall efficiency of organization/nation (cf., Ackoff and Rovin 2003; Coccia, 2021b).

Overall, then, the proposed indexes here provide main information in terms of performance of countries to cope with COVID-19 pandemic crisis. The proposed indexes can be applied in a general strategy to help policymakers to know points of strength but also of vulnerability and design effective policy responses to cope with infectious diseases and to prevent future outbreaks of the COVID-19 and other new viral agents. Of course, suggested indexes need to be updated periodically as more data become available in order to provide correct information to support effective decision making. However, the proposed indexes have the limit to consider some indicators but other factors should be included in future development of this new method. Therefore, to conclude, this study encourages further investigations for developing comprehensive indexes of performance for crisis management also based on environmental and socioeconomic factors, and not only on parameters related to medicine that can help policymakers to evaluate manifold aspects to reduce vulnerabilities to epidemics and support the design of appropriate short-run and long-run strategies to prevent future epidemics and to contain the negative impact of infectious diseases on public health, economy and society.

Declaration of competing interest

The author declares that he is the sole author of this manuscript and he has no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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